DESIGN SUITABLE PUNCH OR DIE TO OVERCOME SPRINGBACK ON U-BENDING

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A report submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Manufacturing Engineering

Faculty of Manufacturing Engineering
UNIVERSITY MALAYSIA PAHANG

JUNE 2012

ABSRACT

This project deals with the overcoming springback on u bending. Now days, many research and study have been done on a springback. In sheet metal bending, a flat part is bent using a set of punches and dies. The punch and the dies are mounted on a press machine, which control the relative motion between the punch and die and provides the necessary bending pressure. This project is done with simulation of springback using a material of Stainless Steel on U-bending process by using a 1 mm thickness and the size of the specimen is 100 mm x 90 mm. The springback of Stainless Steel sheet was investigated using finite element analysis. Hyperform software is used in this project to simulate the springback of sheet metal in U-bending. The main problem of the bending process is spring-back phenomenon after removing the punch. The aim of this study includes the springback optimization of the part that required U bending processes using the concept of experimental design a suitable punch or dies.

ABSTRAK

Projek ini berkaitan dengan mengatasi penganjalan pada u membengkuk. Sekarang ini, banyak penelitian dan pelajaran telah dilakukan pada sebuah penganjalan. Dalam lembaran logam lentur, bahagian datar dibengkokkan dengan menggunakan satu set penebuk dan acuan. Penebuk dan acuan terpasang pada mesin penekan, yang mengawal gerakan relatif antara penebuk dan acuan dan memberikan tekanan lentur yang diperlukan. Projek ini dilakukan dengan simulasi penganjalan menggunakan bahan dari Stainless Steel tentang proses membengkuk berbentuk U dengan menggunakan ketebalan 1 mm dan ukuran spesimen adalah 100 mm x 90 mm. Penganjalan pada bahan Stainless Steel diteliti menggunakan analisis elemen. Simulasi Hyperform digunakan dalam projek ini untuk mensimulasikan penganjalan dari lembaran logam pada acuan berbentuk U. Masalah utama dari proses ini adalah mengehadkan kembali fenomena setelah melepaskan penebuk. Tujuan dari penelitian ini merangkumi optimasi penganjalan dari bahagian yang diperlukan proses membentuk U dengan menggunakan konsep experimen pada penebuk dan acuan.

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σ_{xz}	Shear stress
γ_{xz}	Shear strain
W	Wise portion

LIST OF ABBREAVIATION

FEA	Finite Element Analysis
CRES	Called Corrosion-Resistant
CAD	Computer Aided Design
UTS	Ultimate Tensile Strength
TS	Tensile Strength
FEM	Finite Element Modeling
3D	3-Dimension
2D	2-Dimension
EDM	Electric Discharge Machine

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter will discuss about the project background, problem statement, and project objective and the scope of the project.

1.2 PROJECT BACKGROUND

In the broadest, most general sense, bending process is an important process in the sheet metal forming in many industries. The main problem of the bending process is spring-back phenomenon after removing the punch. Any parts that involve bending are subjected to spring back. Spring back will affect the part accuracies. In study analysis to experimental design a suitable punch or dies to overcome the spring back of the part that required in U bending.

Variables and their effect on springback are harder sheet metal have greater degrees of springback due to a higher elastic limit and the resulting larger elastic band at the bend. Then, a sharper or smaller bend radius reduces springback by creating a larger plastic zone and could cause tearing, due to higher stresses in the outside surface. After that, as metal is bent through greater degrees of bend, the plastic zone is enlarged and springback is reduces for each degrees of bend. Total springback is increased. However, the thicker sheet metals have less springback because more plastic deformation occurs considering no change in the die radius.

On the other hand several methods are used to overcome spring back. These are overbending, bottoming or setting and stretch bending. The sheet metal is often overbent amount sufficient to produces the desired degree of bend or bend angle after springback. For the overbending may be accomplished by using cams, by decreasing the die clearance or by setting the punch or die steel at smaller angle than required in the case on U die. When the clearance is reduces below the sheet metal thickness, the burnishing action wipes the metal against an undersized punch or die steel.

Although the bottoming or setting consist of striking the metal severely at the radius area. This places the metal under high compressive stresses that set the metal past the yield strength. Bottoming is accomplished by placing a bead on the punch at the bend area. The pad must bottom against the shoe or backing plate so that the punch may set the metal at the bend. It would be useless to bottom against the flat area of the sheet metal because they are not stressed and do not cause springback. Bottoming must be carefully controlled when adjusting press ram or the forced involve will rise at rapid rate.

Stretch bending consists of stretching the blank so that all the metal is stressed past the yield strength. The blank is then forced over the punch to obtain the desired contour. This prestressing before bending results in very little springback. Only relatively large radius is bent because sharp radius would take the prestressed metal beyond the ultimate tensile strength. The sheet metal must be uniform in strength. Stretching bending is most frequently done with a special hydraulic machine rather than with a die in a press.

1.3 PROBLEM STATEMENT

Sheet metal stamping plays a major role in many industries today. As part components get smaller and tolerances get tighter, the dimensional accuracy of a stamped part becomes a crucial factor in determining the overall quality of the part. In most, if not all, sheet metal forming processes, springback is the major problem faced. Springback often complicates the design of forming dies, and final die designs may only be accomplished after fabrication. This poses significant problems to designers, who must accurately assess the amount of springback which occurs during a forming process so that a final desired part shape can be obtained.

1.4 OBJECTIVES

1. To conduct on experimental design in order to find a suitable punch or dies that can overcome the springback of the part in required U bending.
2. To validate the resulting springback using hyperform simulation and compare with resulting on experiment.

1.5 SCOPE OF THE PROJECT

1. U-bending analysis based on hyperform software
2. To conduct experiment on sheet metal bending.
3. Analyze and compare the simulation and experiment result.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will discuss about the types of bending and material. It also discuss about meaning of springback, yield point and ultimate tensile strength. Bending, springback and related equations are among the interested terms in this chapter. The source from literature review is from journals, articles and books. Literature review is done to provide information about previous research and that can help to smoothly run this project.

2.2 THEORY OF SHEET METAL BENDING

A process by which metal can be deformed by plastically deforming the material and changing its shape is called bending. The material is stressed beyond the yield strength but below the ultimate tensile strength. The surface area of the material does not change much. Bending usually refers to deformation about one axis. [2]

Bending is a flexible process by which many different shapes can be produced. Standard die sets are used to produce a wide variety of shapes. The material is placed on the die, and positioned in place with stops and or gages. It is held in place with hold-downs. The upper part of the press, the ram with the appropriately shaped punch descends and forms the v shaped bend.

In sheet metal we can use it to bend. Not all sheet metal has a correct angle when it was bending. This phenomenon calls spring-back. Spring-back occur until residual stress forces are balanced by the material’s stiffness. There are some factors that affect spring-back such as higher material strength, thinner material, lower young’s modulus, larger die radius, greater wipe steel clearance, less irregularity in part outline and flatter part surface contour. Spring-back parameters are mainly influenced by the following factors punch and die radius, punch and die angles, initial clearance, friction conditions, blank holder force, draw beads geometry, sheet thickness, elastic modulus, Poisson's coefficient, blank material and constitutive behavior of the material in plastic field.

2.3 TYPE OF BENDING PROCESS

A bending tool must be decided depending on the shape and severity of bend. Following are the different types of bending commonly used for precision sheet metal bending. [1]

(a) "U" Bending
(b) "L" Bending
(c) "V" Bending

2.3.1 U- BENDING

U-bending is performed when two parallel bending axes are produced in the same operation. A backing pad is used to force the sheet contacting with the punch bottom. It requires about 30% of the bending force for the pad to press the sheet contacting the punch. Figure 2.1 shows an example of U-bending process.

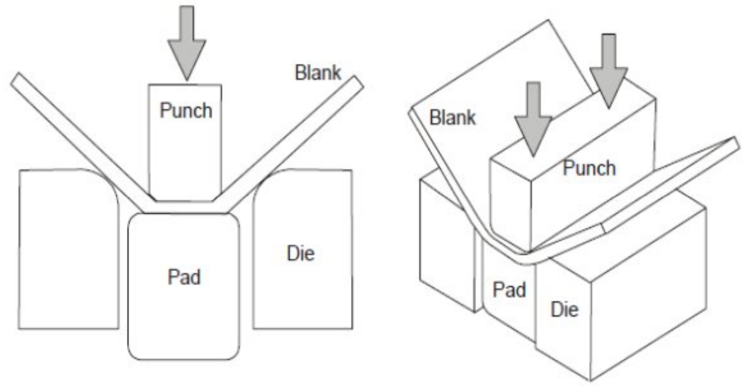

Figure 2.1: Diagram of U-bending process (Source: Diegel, 2002)

2.3.2 L- BENDING

Wiping die bending is also known as flanging. One edge of the sheet is bent to 90º while the other end is restrained by the material itself and by the force of blank holder and pad. The flange length can be easily changed and the bend angle can be controlled by the stroke position of the punch. Figure 2.2 shows of L-bending process.

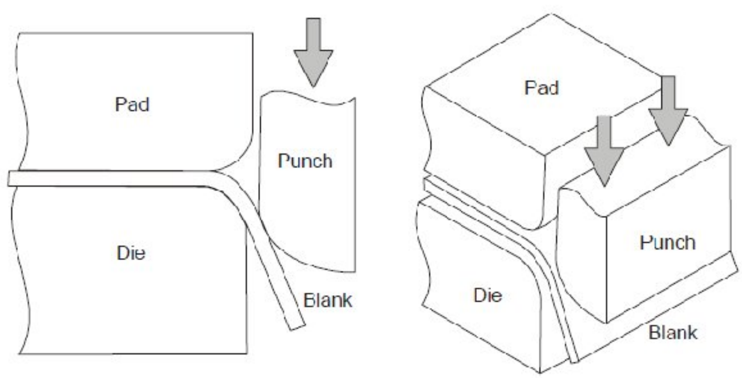

Figure 2.2: Diagram of L-Bending (Source: Diegel, 2002)

2.3.3 V-BENDING

Figure 2.3 shows of V-bending process. In V-bending, the clearance between punch and die is constant (equal to the thickness of sheet blank). The thickness of the sheet ranges from approximately 0.5 mm to 25 mm.

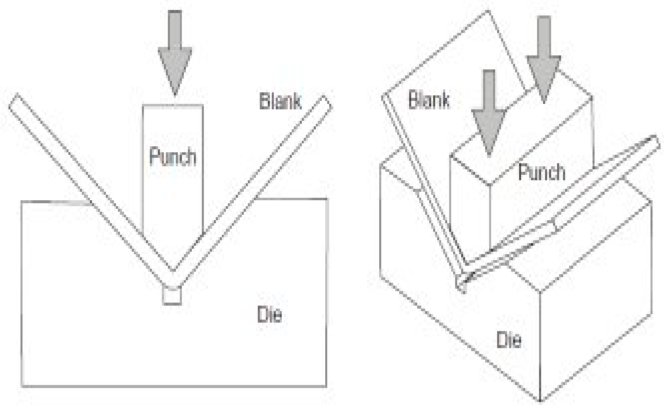

Figure 2.3: Diagram of V-bending process (Source: Diegel, 2002)

2.4 BASE EQUATION OF BENDING FORCE

The equation for maximum bending force is,

$$F_{\max} = k\frac{(UTS)Lt^2}{W} \qquad (1.0)$$

Where k is a factor taking into account several parameters including friction, and *L* and *t* are Length and thickness of sheet metal respectively. The variable W is opening width of a V-die or Wiping die. [1]

2.5 STRESS-STRAIN CURVE

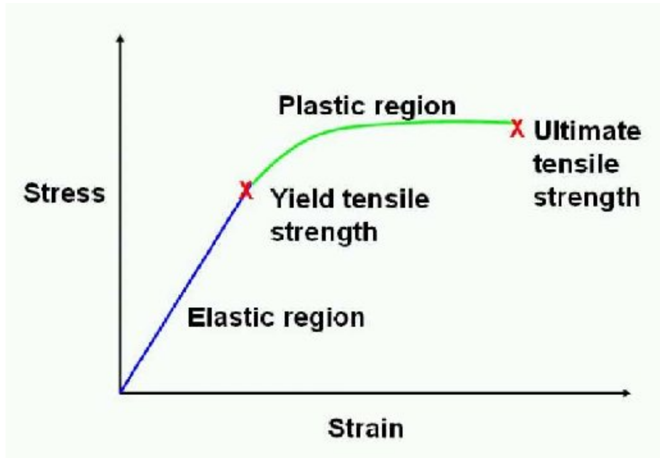

Figure 2.4: Stress-Strain curve

2.5.1 Yield Point

The yield point is that point when a material subjected to a load, tensile or compression gives and will no longer return to its original length or shape when the load is removed. Some materials break before reaching a yield point, for example, some glass-filled nylons or die cast aluminum. To try to further visualize this property, take a piece of wire and slightly bend it. It will return to its original shape when released. Continue to bend and release the wire further and further. Finally, the wire will bend and not return to its original shape. The point at which it stays bent is the yield point. The yield point is a very important concept because a part is usually useless a material has reached that point. [12]

2.5.2 Ultimate Tensile Strength

Ultimate tensile strength (UTS), often shortened to tensile strength (TS), or ultimate strength, is the maximum stress that a material can withstand while being stretched or pulled before necking, which is when the specimen's cross-section starts to significantly contract. Tensile strength is opposite of compressive strength and the value can be quite different. The UTS is usually found by performing s tensile test and recording the stress versus strain and the highest point of the stress-strain curve is the UTS. It is an intensive property, so its value does not depend on the size of the test specimen. However, it is dependent on other factor, such as the preparation of the specimen, the presence or otherwise of surface defects, and the temperature of the test environment and material. [12]

2.6 Plane Stress

Plane stress is defined to be a little of stress in which normal stress σ_z and shear stress σ_{xz} and σ_{yz} directed perpendicular to the x-y plane one assumed to be zero. The geometry of the body is essentially that at a plate with one dimension much smaller than the others. The loads applied uniformly over the thickness of the plate and act in the plane of the plate. The plain stress condition is the simplest form of behavior for continuum structures and represents situation frequently encountered in practice. [8]

2.7 Plane Strain

Plane strain is defined to be a state in which the strain normal to be x-y plane, ε_z and the shear strain γ_{xz} and γ_{yz} are assumed to be a zero. In plane strain, one deals with a situation in which dimension of the structure in one direction, say z-coordinate direction is very large in comparison with the dimension of structure in the other two directions (x and y coordinate axes). The geometry of the body is essentially that of a prismatic cylinder with one dimension much larger than others. The applied force acts in the x-y plane and do not vary in the z-direction, for example the load uniform distributed with respect to the large dimension and act perpendicular to it. Some important practical application of this representation occur in the analysis of dam, tunnels and geotechnical works also such small scale problem as bar and roller compressed by forces normal to their cross section one amenable to analysis to this way. This report will used a plane strain in simulation in springback. [9]

2.8 SPRINGBACK

Springback is the elastically-driven change in shape of a part upon unloading after forming, is a growing concern as manufacturers increasingly rely on materials with higher strength-to-modulus ratios than the traditional low strength steel [3]. Effect of springback is by changing the shape and dimension which is create major problem in the assembly.

The springback deformation of sheet metal parts is natural result of a sequence of deformation experienced in metal forming process. As the sheet metal slides over a die shoulder, it undergoes bending-unbending deformation developing cyclic bending loads on the sheet sections, and as a result an unbalanced stress distribution is developed over the thickness. [3]

There are two terms that are important in springback namely; springback controlling during forming and springback prediction in die design stage. Springback may not be categorized as a defect. However this geometrical discrepancy can cause ill-fitting in part assembly and geometric deviation of the intended design. If springback could be predicted, the tool and die could be accurately designed and built. There are many factors could affect springback in the